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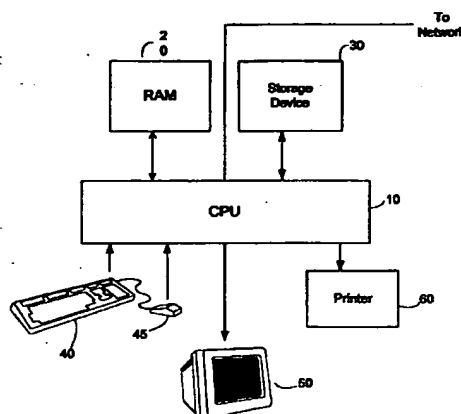
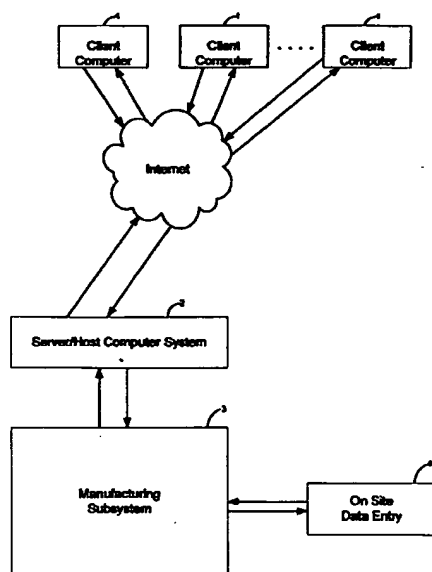
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(54) Title: **HIGH RESOLUTION INK-JET PRINTING ON EDIBLES AND PRODUCTS MADE**



(57) Abstract: Disclosed are methods of printing high resolution images on edible substrates with dispersed pigmented inks using a drop-on-demand ink-jet printer. Dispersed pigmented white inks useful with the inventive methods are also disclosed. White images having a resolution greater than 200 dpi can be printed on chocolate using the methods and inks disclosed herein. The inventive methods and inks may also be integrated with a consumer-driven site vending or e-commerce application in which the consumer provides the image to be printed and edibles bearing the printed image are prepared for rapid turnaround.

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## TITLE

HIGH RESOLUTION INK-JET PRINTING ON EDIBLES AND  
PRODUCTS MADE

5

## BACKGROUND OF THE INVENTION

## Field of the Invention

10 The invention is directed to high resolution printing  
on edibles using an ink-jet printer and dispersed  
pigmented inks. The system provides for rapid  
turnaround from image input to printed edible product.  
Methods of printing, ink formulations suitable for use  
15 with the methods, site-vending and e-commerce  
applications are all described herein, and are within  
the intended scope of the invention.

## Description of the Related Art

20 Highly detailed images can be formed on chocolates  
using a pad printing process. In this process, the  
substrate is contacted with an inked pad having the  
image formed thereon. Sometimes, in order to prepare  
an image having greater resolution, the chocolate is  
25 contacted repeatedly with the pad. An example of a pad

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printing process is described in CA 2,057,985. While, the pad printing process can deliver highly detailed images it cannot be adapted for rapid turnaround applications. Each requested change to an image  
5 requires that a corresponding change be made to the printing pad or the manufacture of a new pad which means that pad printing will have a slow turnaround time. One object of the invention, therefore, is to provide for rapid turnaround printing of high  
10 resolution images on edibles.

Ink-jet printing systems are generally of two types: continuous jet and drop-on-demand. In continuous jet ink-jet systems, ink is emitted in a continuous stream  
15 under pressure through at least one nozzle. The stream is broken up into droplets at a fixed distance from the orifice. Typically, the ink droplets in continuous ink-jet systems are formed by a piezoelectric crystal, which is vibrated at controlled frequency adjacent to  
20 the ink stream. To control the flow of ink droplets, these inks are charged (by addition of salts and other conductive agents) and relayed in accordance with digital data signals. The droplets are passed through an electrostatic field, which adjusts the trajectory of  
25 each droplet. The droplets are either directed back to a gutter for recirculation or to a specific location on the substrate to create the desired character matrix.

In drop-on-demand systems, a droplet is expelled under  
30 pressure from a valve directly to a position on the substrate in accordance with the digital data signals. A droplet is not formed or expelled unless it is to be

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jettied to the substrate. The formation of droplets in drop-on demand systems can either be achieved by a piezoelectric crystal (similar to continuous jet systems) or by a thermal (bubble-jet) technique. The latter technique involves formation of ink droplets by thermally heating ink in the cartridge reservoir thereby forcing ink to be expelled in an "on-demand" basis. Typically, drop-on-demand systems print at a slower rate than continuous jet systems (due to time required to make droplets on demand) but produce higher resolution images. However, some of the commercially available printhead units (for example, manufactured by Xaar, Trident and Picojet) achieve high throughput rates even with drop-on-demand systems by using their proprietary technologies. Also, since drop-on-demand systems require no ink recovery, charging, or deflection, these systems are simpler than the continuous stream systems.

Further, continuous jet ink-jet printing systems do not yield the same high resolution images that can be obtained with drop-on-demand ink-jet systems. A typical maximum resolution for a continuous jet printer image on an edible substrate using a single printhead and a single pass printing is about 70-90 dpi.

Published European Patent Application EP 705 890 A1 discloses an ink for use with a continuous ink jet printer. The ink comprises pigment, such as titanium dioxide; binder, such as shellac or poly(1-vinyl-2-pyrrolidone); and an aqueous carrier. The binder is apparently required to increase the compatibility of

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the inked image with the substrate in the continuous ink-jet environment contemplated.

Other methods of decorating edibles are known in the prior art. UK Patent GB 2,291,838 B describes a machine and method for printing on an edible substrate. This patent discloses a generic ink-jet/bubble-jet head assembly together with a stepping motor for moving the head assembly. A pump provides food coloring to the head assembly from ink reservoirs. A computer provides the instructions for printing on the edible substrate.

Food colorings which are dye-based systems behave differently than dispersed pigmented inks in an ink-jet environment, and exhibit profoundly different image characteristics on edible substrates. Dye-based inks possess limited opacity and therefore do not hide dark backgrounds colors, such as milk chocolate and dark chocolate surfaces. Also, dye-based inks are not available in all colors. For example, white ink is not available as a dye system but is available only as a pigmented (dispersed) system.

The examples of the prior art do not describe methods or systems to print high resolution images on edibles using an ink-jet printer and pigmented inks. There is also no description of a system or method wherein a consumer can participate in the selection and customization of an edible product with a high resolution image and subsequently receive the customized product in rapid fashion.

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## BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1A is a block diagram showing the elements of a system for preparing edibles having high resolution images ink-jet printed thereon.

Figure 1B is a block diagram of a manufacturing subsystem of the system of Figure 1A.

## 10 SUMMARY OF THE INVENTION

It is an object of the invention to provide a customizable process for preparing edibles having high resolution images that have been selected by a consumer ink-jet printed thereon according to the invention that comprises the steps of: selecting digital image information; processing the digital image information to form processed digital image information; ink-jet printing an image corresponding to the processed digital image information using dispersed pigmented ink; wherein said step of selecting digital image information is performed by an individual consumer.

The input of the individual consumer is a key component of the customizable process according to this embodiment of the invention. Rapid turnaround from the consumer's selection of digital image information to finished product having high resolution images printed thereon makes possible the consumer's involvement in the manufacture of personalized products.

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In preferred embodiments, the above system for preparing edibles having high-resolution, consumer selected images printed thereon, is embodied in connection with a rapid-turnaround site-vending or e-commerce application. In these embodiments, the consumer selects digital image information, at a vending site or over the internet, for example. The information is processed, remotely or on-site, and printed onto an edible substrate with an ink-jet printer using the dispersed pigment food grade inks of the invention. The entire process is accomplished according to consumer selections with rapid turnaround. In some embodiments, the turnaround can be on an as-you-wait basis.

15

It is a further object of the invention to provide a process for printing high resolution images on an edible substrate comprising the steps of: (a) providing digital image information; (b) processing the digital image information to prepare processed digital image information; and (c) printing an image from the processed digital image information on an edible substrate with a drop on demand ink-jet printer using dispersed pigment food-grade ink to obtain a printed image having resolution greater than 200 dpi.

Significantly, the image resolution (as measured in dots per square inch, (dpi)) achieved using the process of this invention may be obtained even using a single printhead and single pass printing. Of course, the invention set forth herein is not limited to a single printhead or single pass printing, but also includes

30

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the use of multiple printheads and/or multiple pass printing.

It is a further object of the invention to provide a  
5 system for preparing edibles having high-resolution,  
consumer-selected, dispersed pigmented ink images  
printed thereon with an ink-jet printer, comprising: a  
digital image information selection device in  
communication with an image processor for producing  
10 processed digital image information and an ink-jet  
printer adapted to print a high resolution image  
corresponding to said processed digital image  
information on an edible substrate.

15 It is also an object of the invention to provide novel  
edible dispersed pigmented ink compositions which can  
be used in drop on demand ink jet systems to deliver  
high resolution images.

20 Novel edible, ink-jetable ink compositions according  
to the invention comprise: a food-grade white pigment,  
a dispersant, an alcohol, and water.

In a particular embodiment, the present invention  
25 comprises a food-grade, drop-on-demand ink jetable ink  
consisting essentially of: titanium dioxide, glycerine  
and/or propylene glycol and/or polypropylene glycols, a  
lower alcohol, water, and optionally a surfactant. In  
a preferred embodiment, the ink is substantially free  
30 of binder.

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It is also an object of the invention to provide high resolution images on edible substrates with dispersed pigmented inks printed with drop-on demand ink-jet technology. Particularly preferred embodiments

5 according to the invention include white ink images having a resolution greater than 200 dpi, and more preferably between 300 and 1200 dpi, printed with drop-on demand ink-jet technology on chocolate substrates.

10 In a particular embodiment, novel high resolution printed edible products are described, wherein a printed image is printed on a surface with localized three dimensional (3-D) features, for example an irregular or uneven surface.

15

It is a further object of the invention to provide a computer-readable medium storing executable code adapted to control a server computer on a network to perform a method for facilitating custom manufacturing  
20 of a decorated edible item on the basis of instructions of a user. The method includes communicating over the network with a client computer of the user, receiving over the network, from the client computer, image information submitted to the client computer by the  
25 user, and communicating the received image information to an ink-jet printer to cause printing on an edible item of a high quality image that corresponds with the received image information.

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## DESCRIPTION OF THE PREFERRED EMBODIMENTS

An important motivation behind the use of ink jet printing is that this type of printing allows rapid  
5 turnaround from the selection of an image to the printing of edibles bearing the selected image. The rapid turnaround enabled by the use of ink-jet printing (as opposed to pad printing) permits a consumer to dictate the steps of digital image information  
10 selection and image processing. The rapid-turnaround, consumer-centered approach to printing on edibles permits the introduction of applications heretofore not deemed possible, or if possible, impractical.

15 In some embodiments, the present invention comprises a system for preparing edibles having high-resolution, consumer-selected and/or consumer-provided images printed thereon. The consumer's involvement in the preparation of an individualized edible is a key  
20 component of these embodiments of the invention. Thus, in the system, a digital image selection device is consumer-driven.

The process for printing high resolution images on an  
25 edible substrate according to the invention comprises, in the first instance, the step of providing digital image information. The source of the digital image information is not particularly limited. Digital image information for use with the printing process of the  
30 present invention may be in the form of an electronic file (on disk or otherwise), or may be transmitted from a source. Providing digital image information may be

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accomplished, for example, with a keyboard, a digital camera, a scanner, a digital video camera, or the image may be provided in pre-recorded image format.

Presently available technology includes many sources of  
5 digital image information that would be known to those of ordinary skill in the art, and which could be readily used in the step of providing digital image information.

10 Digital information must be in communication with the image processor. Communication may be effected over the Internet, by a computer, through computer cables, wiring, fiber optic cabling, or other means through which digital image information can be transmitted.

15 Specifically contemplated herein is an embodiment wherein a digital image information selection device is incorporated with the image processor. For example, a digital camera typically includes options for processing an image. In this situation, the digital  
20 image information selection device is said to be in communication with the image processor. Likewise, when digital image information is captured by a digital image information selection device and placed on a storage medium, and thereafter the digital image  
25 information is loaded into a software package for processing the image, the digital image information selection device is said to be in communication with the image processor. Similarly, when digital image information is received over the Internet by the server  
30 functionality of the present invention, this will constitute the communication. The structural details

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of these programs or communicating devices are well known.

In preferred embodiments, the digital image information  
5 is provided under the direction or control of individual consumers. A site-vending application can include an area, such as a kiosk, where the consumer is provided with a digital camera, keyboard, computer terminal or the like to prepare individualized digital  
10 image information. Of course, any type of device capable of providing digital image information, such as personalized messages, sentiments or a clip-art image selected by the consumer from a library of such images may be used. The digital image information may be then  
15 processed at the site and printed on an edible substrate, such as chocolate, on an as-you-wait basis.

In a preferred embodiment, consumers provide individualized digital image information at a computer  
20 which is linked on-line to the internet. In either the site vending or internet embodiments of the present invention, there is rapid turnaround between the consumer's selection of digital information and obtaining edibles printed with the selected images.

25

In a particularly preferred embodiment of the present invention, the system utilizes a wide area network (WAN) such as the Internet to receive custom orders from consumers for designs to be printed on the edible  
30 items. The system preferably includes an Internet (TCP/IP compliant) server that interacts with consumer client computers using the client computer's graphical

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user interface (GUI). The interface with the consumer preferably allows the consumers to interactively peruse options for decoration of edibles, and more preferably, the ability to preview what the final product will look  
5 like. The above functionality is preferably achieved using a combination of server side applications, such as common gateway interface programs (CGI), for allowing the server to accept search terms and interface with databases, and client side applets, such  
10 as Java applets, or the like, which execute in client browser software.

A preferred implementation of the consumer customized manufacturing system of this present invention is  
15 illustrated in block diagram form in Figure 1A. In that figure, consumers operating client computers 1 are connected to a wide area network (WAN) such as the Internet. Such connection can be direct or via an Internet service provider (not shown). The client  
20 computers 1 each preferably include communications hardware and an operating system with graphical user interface (GUI) functionality to allow for interface with the Internet. Each client computer preferably has graphical World Wide Web (Web) browser software, such  
25 as Netscape Navigator or Microsoft Internet Explorer, loaded thereon operable to read and send Hypertext Markup Language (HTML) forms from and to an Hypertext Transport Protocol (HTTP) server on the Web. The client computer 1 preferably is operable to act as a  
30 virtual machine to run Java applets, or the like, downloaded by the browser from the server.

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Server/host computer system 2 receives information from consumer client computers 1 over the Internet. The server/host computer system 2 preferably includes hardware, HTTP compliant software, an operating system  
5 and common gateway interface (CGI) software for interfacing with input queries and sources of data.

Manufacturing subsystem 3, to be described in more detail below, includes the hardware and software  
10 necessary to interface with the server/host computer system 2 and to use the input information to custom manufacture decorated edible items. On site data entry 4 allows on site entry by consumers of custom orders as an alternative to receipt of this information over the  
15 Internet.

A preferred implementation of manufacturing subsystem 3 is illustrated in block diagram form in Figure 1B. Central Processing Unit (CPU) 10 is a computer having  
20 the functionality to run software programs, communicate with outside sources of data, and control peripheral devices. Preferably, the CPU 10 is operable to configure data for graphical display from input data received from server/host computer system 2 and on site  
25 data entry 4, as well as from graphical data files stored in storage device 30, or RAM 20. A user can interface with the CPU 10 using keyboard 40 and/or mouse 45, preferably using a GUI operating system. Printer 60 is used to decorate the edible items under  
30 the control of the CPU 10 based upon the graphical data. Prior to printing, the graphical data may be subjected to modification by the user of the CPU 10, if

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necessary, by using the keyboard 40 and/or mouse 45 in conjunction with the GUI.

In operation, in the Internet implementation, a  
5 consumer typically would type in a Uniform Resource  
Locator (URL) of the server/host computer system 2 and  
receive from the server/host computer system 2 an  
interactive form, such as an HTML document, as well as  
any Java applets, or the like, necessary to allow the  
10 consumer to view and submit his or her options for  
customizing the decoration of the edible items. The  
applets and CGI programs do verifications to ensure,  
for example, the consumer does not chose too large a  
decoration for the edible. Assuming the consumer  
15 request is within appropriate limits, the server acts  
as an intermediary to pass the requested information  
along to the manufacturing subsystem for actual  
printing under the control of CPU 10.

20 An example of the integrated system of the present  
invention includes a method in which the consumer  
selects digital image information while on-line. The  
consumer selects digital image information by entering  
from the keyboard, selecting from a library of images,  
25 inputting a digital photograph, remotely controlling  
the taking of a live digital photograph or video image,  
or other mode available on-line. The consumer then  
communicates, by conventional Internet interfacing  
techniques, the selected digital image information  
30 through server/host computer system 2, to remote image  
processing functionality operating in CPU 10.

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Alternatively, the consumer may simply invoke an image processor while on-line and communicate, in real time, the digital image information to a program for processing an image. Thus, the step of processing the digital image information to produce processed digital image information does not have to be done remotely, but may be accomplished while the consumer is on-line, and under the interactive, real time supervision of the consumer. After the digital image information has been communicated to the image processing functionality of CPU 10, and processed digital image information has been produced, the processed digital image information is transmitted to an ink-jet printer for printing on an edible substrate.

15

The server/host computer system 2 and on site data entry 4, preferably, in addition to communicating to the manufacturing subsystem, communicates with a financial computer of the system to utilize input customer credit card information or the like for payment for the custom decorated edible items. Further, the server/host computer system 2 and on site data entry 4, preferably, in addition to communicating to the manufacturing subsystem and the financial computer of the system, also communicates with an inventory management computer system to coordinate the rapid fulfillment of the customer order through timely shipment of the customized product.

30 In some circumstances, the consumer may be involved in the step of processing the digital image information by changing visual parameters, such as colors, tones,

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brightness, contrast, or the size and aspect ratio of the image, or by cutting-and-pasting or merging images, and the like.

5 If the digital image information is provided over the Internet, software, in the form of Java applets, or the like, for processing the image on the consumer's client computer can be provided on-line. Alternatively, the consumer may be provided with an image processor for  
10 digitally processing the image at the site where the digital image information is provided, for example at on-site data entry 4. Software packages for processing digital image information are known, and the invention is not particularly limited in this regard.

15

An image processor is, generally speaking, a software package that permits sophisticated alteration of digital image information. As indicated above such programs are known in the art. Commercially available  
20 programs that may serve as image processors include, without limitation, Adobe Photoshop and Microsoft Photo Editor. Less involved image processors are contemplated, and might include, without limitation, standard picture controls available on a digital still  
25 camera or digital video camera.

Certain sub-steps involved in the step of processing the digital image information may be "invisible" to the consumer, notwithstanding how the image is provided.  
30 By "invisible" in this context is meant that certain sub-steps of image processing will likely take place without the direct involvement of the consumer. This

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is because certain image processing steps are known from experience to be suitable for particular substrates, such as taking the negative of an image to be printed in white on chocolate, and these steps would  
5 not be expected to be readily apparent to the consumer. Likewise, in some instances it may be desirable to resolve the digital image information into a series of images that are printed on top of one another to create a higher resolution image. This sub-step of resolving  
10 the image into a series of image layers is the type of sub-step that might be "invisible" to the consumer.

In a preferred embodiment[s], the digital information selection device is provided at the same site where the  
15 image processor and the ink-jet printer are located. This type of embodiment can be referred to as a site-vending application, where the consumer selects digital image information, optionally participates in the processing of the digital image, and then waits while  
20 an edible bearing the selected high-resolution image is produced. Of course, the turnaround need not be on an as-you-wait basis. The consumer may place an order and return for it. Nevertheless, rapid turnaround of individually customized edibles is contemplated using  
25 the systems, processes and inks according to the invention.

In a particularly preferred embodiment, the digital information selection device, image processor, and the  
30 ink-jet printer are integrated in a single portable apparatus. For example, a portable apparatus would find application with photographers taking photographs

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at special occasions such as weddings, reunions, etc..  
The rapid turnaround capability of the invention would  
allow the capturing of images of the participants of  
the occasion and the delivery of confectionery products  
5 with their images while they are still at the occasion.

While the preferred embodiments have been described  
above in relation to digital image selection via  
software running on a consumer's client computer 1, or  
10 via on-site data entry 4, the digital image information  
selection device of the present invention is not  
limited to the illustrated embodiments. Examples of  
such selection devices for use on-site may include a  
keyboard or computer terminal, a live video camera  
15 image acquisition device, a digital still camera image  
acquisition device, a scanner, a reader for reading  
digital information, or any other type of device for  
supplying digital image information known in the art.

20 The step of printing an image on an edible substrate  
according to the invention utilizes printer 60, an  
apparatus that may be described as a conventional ink-  
jet printing apparatus modified to operate using the  
edible ink of this invention and modified to print on  
25 the edible substrates of the invention. The preferred  
ink-jet printing apparatus is a drop-on-demand ink-jet  
printing apparatus, comprising a cartridge for holding  
ink which is integrated with a print head for printing  
on the substrate. The apparatus comprises a driver for  
30 driving the print head according to instructions  
corresponding to the processed digital image  
information received. The apparatus typically

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comprises a conveyer for causing relative motion between the substrate and the print-head.

Once the digital image information has been provided,  
5 the image is processed to prepare processed digital image information. This information is then communicated to the printer in appropriate form to enable the printer to produce the high resolution printed image on the edible product. Of course, edible  
10 substrates come in a variety of colors, and printed images will have to be processed at least so that a printed image has the appropriate intensity and contrast for the background color of the substrate. In a preferred embodiment, the printed image comprises  
15 white ink, and the substrate is chocolate. In this situation, the step of processing an image, for example a digital photograph or the like, will involve taking the "negative" of the digital image information, and enhancing image brightness and contrast prior to  
20 printing. This can be accomplished, for example, using an image processor such as Adobe Photoshop.

Dispersed pigmented white ink, which is discussed in more detail below, is provided to the "black" reservoir  
25 or cartridge of a black-only ink-jet printer. Obviously, if a non-white single color image is desired, a pigment based ink containing a dye would be provided to the "black" reservoir of the cartridge. If a printer with a color ink cartridge is utilized, white  
30 ink will be provided to the black reservoir and "colored" pigment based inks will be provided to the remaining reservoirs. The particular arrangement of

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the reservoirs is not particularly critical. It is advisable to sonicate (i.e. ultrasonically mix) the cartridge to effect dispersion of the pigments in the ink prior to printing and intermittently to prevent the  
5 nozzle from becoming clogged.

Once the printer is loaded with ink, the edible substrate is held and conveyed past the print-head (or vice versa). The edible substrate is not particularly  
10 limited. In a preferred embodiment, the substrate is a confectionery product. The substrate may be for example, chocolate, cookies, M&M@s-type candy or other sugar shell candy, or hard candy, jellybeans, starch-based, savory snacks, and gelatin-based gummi and soft  
15 candies. Even ice creams and pet food are within the scope of the invention. In a preferred embodiment, the substrate is a predominantly planar chocolate tablet.

Other embodiments of image processing according to the  
20 invention include, controlling the intensity of the brightest area of an image, electronically separating an image such that it can be printed in multiple applications of ink (i.e., multi-pass through printer), brightness equalization across the printed area, and  
25 sectional control of image brightness and contrast.

Printing on a substrate such as chocolate presents special challenges in obtaining a high quality high resolution image. The use of techniques described  
30 above have been discovered to address many of the challenges. For example, when printing using ink-jet technology onto chocolate, the compatibility of the ink

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with the surface is critical. The surface chemistry of the chocolate surface and that of the ink will determine the behavior to the ink droplets once they have been jetted onto the surface. By controlling the maximum level of brightness for an image, it is possible to ensure that too much ink is not jetted into a given section of a printed image. When this occurs, the ink droplets may tend to coalesce into larger droplets before the ink has had sufficient time to completely dry. This leads to a loss of resolution for the affected section of the image.

Another embodiment is to "separate the image into layers" such that the printing of the complete image is completed by multiple applications of ink. This allows sufficient time for the successive ink applications to dry before another application is made. This allows a larger total application of ink and thus brighter images while avoiding loss or resolution due to coalescence of printed droplets.

Another embodiment utilizes an approach of brightness equalization across the printed area. By adjusting the contrast and shading of the light and dark areas of an image, it is possible to enhance the overall quality of the image on a chocolate surface. This technique tends to minimize extremes of darkness or brightness and results in an improved image quality for images with very severe contrasts.

30

Another embodiment is to control the brightness of an image in certain sections of an image rather than of

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the image as a whole. Here again, the image quality and resolution will be enhanced by avoiding coalescence problems in very bright areas of the image.

- 5 These techniques will generally allow more difficult images to be printed onto chocolate in a manner to deliver a high quality, high resolution image. This is particularly valuable for images with intricate patterns which otherwise might produce lower quality or  
10 lower resolution images.

- As mentioned earlier, the surface chemistry of the ink and the chocolate surface play a critical role in determining the final image quality and resolution.
- 15 Other embodiments according to the invention which can have advantageous effect on image quality include, controlling the surface energy of the chocolate by changing the temperature of the substrate of the ink, using a stream of dry gas to assist the rapid drying of  
20 ink droplets on the surface of the chocolate and applying coatings to the chocolate to enhance the compatibility of the chocolate to the ink.

- Temperature modulation will affect the surface energy  
25 properties of the ink and chocolate with lower temperatures lowering surface energy and reducing the tendency of an ink to spread across the chocolate surface. Applying very low humidity gas or air will enhance the drying rate of the ink droplets and can be  
30 employed effectively with the multi-pass printing embodiment discussed above. Temperature modulation of the ink cartridge can also be advantageously used to

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modify and or control ink rheology to maximize printing performance.

In some instances it may be desirable to enhance the  
5 compatibility of the surface of the confection by  
depositing a thin layer of an edible binder or other  
compatibility-enhancing component prior to the step of  
printing the image. Water-based glazes containing gums  
and/or corn syrups and/or oils, and/or acids and/or  
10 sugars and/or starches and/or low-carbon alcohols  
and/or shellacs and/or other resins provide sufficient  
chocolate surface modification to allow high-resolution  
images to be printed using the above mentioned inks.  
Solvent based glazes may also be useful. Commercial  
15 names of exemplary water-based glazes include, without  
limitation, commercially available Capol 140, Capol  
120, Capol 153D, Capol 149 products, available from  
Centerchem Foods, Stamford, Connecticut. These  
ingredients, besides providing compatibility of inks to  
20 chocolate surface, provide a unique glazed appearance  
to the printed images. Other components which may be  
coated on the surface of an edible substrate prior to  
printing include surfactants, antibloom agents,  
micronutrients and flavor enhancers.

25

An example of a surfactant than can improve the  
compatibility of the ink with a chocolate surface is  
Adsurf 456K. Application of a thin layer improves the  
image quality and resolution significantly. Another  
30 embodiment of the invention involves the application of  
more than one surface pre-treatment layer prior to ink-  
jet printing. Among surface pre-treatments, the

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application of a Capol glaze to the chocolate surface provided the best surface in terms of ink compatibility. However, it is very difficult to deliver a uniform layer of the Capol glaze to the chocolate surface. Surprisingly, it has been found that combining a first pre-treatment application of a surfactant, such as Adsurf 456K, followed by a second application of Capol provides a very significantly improved surface for ink-jet printing. The sequential application of this multi-layer pre-treatment, using a foam brush, provides a smooth highly compatible surface for edible pigmented ink-jet ink. This delivers a very superior image quality and resolution. This surface is also much less prone to ink droplet coalescence problems.

The image enhancement techniques discussed in application to chocolate products are not limited to these products but are generally applicable in principle to other edible substrates.

The present invention also provides for novel high resolution printed edibles wherein the edibles have a substantially planar or substantially non-planar shape. As used herein, substantially planar includes, for example, a chocolate tablet, while substantially non-planar includes, without limitation, an interior or exterior surface having curvature, such as an egg. The novel printed edible is printed on at least one surface having localized 3-D features if substantially planar. If substantially non-planar, the printed surface may be on localized 3-D features. Localized 3-D features can

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include, without limitation, uneven or irregular surfaces, such as grooves, ridges, pinholes, and the like, as well as embossed or molded designs in the edible substrate.

5

In preferred embodiments, the edible may be moved or rotated in an appropriate manner to transiently bring a non-planar surface into correct position and distance for printing below or aside a drop on demand printer head. For example, high resolution images can be printed on a Chocolate Easter Egg by a system which holds the egg and moves it past a horizontally mounted printer head in rotational manner to present an arc of the egg surface for printing. In a particularly preferred embodiment the system will control the edible in such a manner as to transiently maintain the non-planar surface being printed at a perpendicular angle to the print head.

20 In another preferred embodiment, it is possible to print the interior surface of a  $\frac{1}{2}$  egg or  $\frac{1}{2}$  ball shaped product produced by shell molding and which is ultimately joined to another half to yield a hollow molded edible product.

25

In formulating an ink composition that is edible, ink-jettable, and which provides an acceptable high-resolution high quality image, several competing factors need to be addressed. Generally speaking, a dye-based ink will not provide an acceptably high-quality image on most edible substrates, such as dark surfaced substrates and/or non-porous materials, due to

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poor image contrast and therefore, the invention is directed primarily to dispersed pigmented inks.

The edible dispersed pigmented inks of the invention  
5 are generally prepared in the following manner. First, the pigment dispersion is prepared by thoroughly mixing an edible pigment with a suitable edible dispersant. Next, the pigment dispersion is carefully diluted or let-down using an edible carrier fluid to produce the  
10 dispersed pigmented ink. As the inks of the invention are water based, the carrier fluid will typically be comprised of water and an edible alcohol. Optionally, an edible surfactant may be added to the ink, either at the dispersion step or later.

15

In preparing dispersed pigmented inks, enough pigment must be used in the formulation to lend sufficient opacity to the printed image, and it must be ensured that the pigment is uniformly dispersed in the ink. In  
20 the production of a white ink, at least about 3 weight percent of white pigment is required to provide sufficient opacity and dispersivity in the ink. At the same time, if too much pigment is used, the resulting ink will tend to clog the nozzle orifices of an ink-jet  
25 printer, particularly a drop-on-demand ink-jet printer. Additionally, at high pigment levels, the ink viscosity is increased to levels such that flowability of ink within the ink cartridge and nozzles is restricted. Thus, an upper compositional limit for pigment in the  
30 edible ink composition according to the invention is about 55 weight percent. Where titanium dioxide is used as the pigment the desirable range is between 10-

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45 weight percent and the most preferred amount of pigment to use is about 13-35 weight percent. As used herein "weight percent" means percent by weight with respect to the weight of the ink composition, unless  
5 specifically stated otherwise.

Powdered materials that may be used as a pigment in the edible ink composition according to the invention include, but are not limited to: titanium dioxide,  
10 aluminum hydroxide, calcium carbonate, sucrose, and talc. Titanium dioxide is most preferred.

For use with a drop-on-demand ink-jet system, the pigment particles should have a particle size between  
15 about 0.1 and about 1.5 microns. The preferred titanium dioxide pigments have an average particle size in the range of about 0.2 to about 0.5 microns, with an average particle size of 0.3 microns being the most preferred particle size.

20 To prepare an ink composition according to one embodiment of the invention, first the pigments are dispersed in a dispersant to produce the pigment dispersion. Suitable dispersants include, without  
25 limitation, glycerine and/or propylene glycol and/or polypropylene glycol and other polyglycerols and polyols. A suitable amount of glycerine and/or propylene glycol and/or polypropylene glycol and other polyglycerols and polyols will serve to adequately  
30 disperse the pigment while making sure that fluid properties of the finished ink are not adversely affected. The preferred range of glycerine and/or

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propylene glycol and/or polypropylene glycol and other polyglycerols and polyols in the finished ink is between about 1 percent and about 48 percent.

- 5 According to the invention, other dispersants may also be used beyond those described above. The essential requirements being that the dispersant is edible and effectively disperses the pigment and does not lead to clogging problems of the printer nozzle orifice. For  
10 example, water based carbohydrate and or protein solutions may also be used to disperse the pigment. It is also possible to use combinations of dispersants. It is also possible to use salts or other compounds to charge the pigmented particles and therefore help  
15 disperse the pigments.

The ink compositions according to the invention are typically water-based. Preferably, water comprises between about 30 and about 75 weight percent of the  
20 final ink composition. In yet another embodiment, the ink composition may also be substantially free of water.

An alcohol is added to the ink composition as part of  
25 the carrier so that the image will dry quickly once printed. Any alcohol suitable for use with an edible composition that will increase the volatility, and therefore the drying speed, of the ink may be used. Lower alcohols, and in particular ethanol and isopropyl  
30 alcohol, are preferred. Enough alcohol must be used to ensure that the ink will dry quickly, but not so much that the flashpoint of the ink composition is reduced

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to a dangerous level. The preferred range of alcohol is between about 5 and about 70 weight percent of the final ink composition. A more preferred range is between about 7 weight percent and about 45 weight  
5 percent. The most preferred range of alcohol is between about 10 weight percent and about 25 weight percent with respect to the final ink composition.

The edible ink composition according to the invention  
10 may also comprise a surfactant to improve the compatibility of the ink with the surface of the chocolate. The surfactants that may be used in the ink of this invention include, for example, anionic surfactants, cationic surfactants and amphoteric  
15 surfactants. Of course, the surfactant used must be edible in the amounts used. The most preferred surfactants are polyglycerol oleates, monostearates, polysorbates, mono and diglycerides, commercially available under the tradenames of Adsurf 456K, Tween  
20 60, Tween 80, Span 60, and Span 80, Myverol and Myvecet. Generally, a surfactant will be present in amounts less than about 1.0 weight percent. Most preferably, the surfactant will be present in an amount between about 0.001 and about 0.5 weight percent (based  
25 on final ink-formulation).

As the composition is an edible composition, a simple composition is preferred. The edible ink according to preferred embodiments of the invention is substantially  
30 free of shellac or polymeric binder. It has surprisingly been found that the composition as recited above, with the optional addition of a small amount of

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surfactant is sufficient to obtain good image durability and compatibility of the image with a chocolate substrate.

5 Other ingredients may be added to the ink including, but not limited to flavor enhancers and micronutrients. Such components, frequently added to the surfaces of edibles, particularly confections, would be known to one of ordinary skill in the art and include, without  
10 limitation, mint, fruit and vegetable oils, herbal extracts, cinnamon and coffee flavorings, vanillin and vanilla extracts (natural and artificial), malt flavors, vitamins, minerals, plant phytochemicals, anthocyanins, etc. Although not particularly limited  
15 in this regard, it is contemplated that these flavor enhancers and micronutrients may be present in an amount between about 0.01 weight percent and about 5 weight percent. Further, the flavor enhancers and micronutrients added according to the invention may be  
20 suitable for either human or animal palatability and health.

As noted earlier, the use of dyes on most edible substrates does not produce a satisfactory image.  
25 However, the ink composition of the present invention may include dyes in addition to the pigment. It has surprisingly been found that combining dyes with titanium dioxide pigment yields colored inks having greater intensity and opacity than when the food dyes  
30 are used as sole colorants in an ink formulation. It is also within the scope of the invention to use lakes

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in combination with titanium dioxide pigment in a colored ink composition.

Generally, if dyes are present, the amount will range  
5 between about 0.5 and 5.0 weight percent with respect  
to the edible ink composition. Water based dyes such  
as F D & C approved colors, natural colorants and mica-  
based metallic color pigments are preferred for use  
with the edible inks of the invention.

10

A consumer-driven, customizable process for producing  
edibles having individualized, high-resolution images  
printed thereon is made possible by the invention. The  
full scope of the invention is set forth in the  
15 appended claims, and includes equivalents and  
alternatives of the disclosed inks, processes, and  
systems and obvious variants thereof.

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## WE CLAIM:

1. An edible, ink-jettable ink composition comprising:

- (a) a food grade white pigment;
- (b) a dispersant;
- (c) an alcohol; and
- (d) water

wherein said ink composition is ink-jettable through a drop-on-demand ink jet system.

2. An edible ink formulation according to claim 1, wherein said ink is capable of forming an image having a resolution greater than 200 dpi using a single printhead and single pass printing.

3. An edible ink composition according to claim 1, wherein said food grade white pigment is titanium dioxide.

4. An edible ink composition according to claim 1, wherein said dispersant is glycerine.

5. The composition according to claim 1, further comprising a dye.

6. The composition according to claim 1, further comprising a surfactant.

7. The composition according to claim 6, wherein said surfactant is selected from the group consisting

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of polyglycerol oleates, monostearates, polysorbates, mono and diglycerides.

8. The composition of claim 3, wherein said ink is substantially free of binder.

9. The composition of claim 3, wherein said dispersant is substantially free of glycerine.

10. The composition of claim 3, wherein said dispersant is a carbohydrate syrup.

11. A food-grade, ink-jetable ink composition consisting essentially of: titanium dioxide, a dispersant, a lower alcohol, water, and optionally a surfactant.

12. The food-grade, drop-on-demand ink-jetable ink composition of claim 11, consisting essentially of about 10 to about 45 percent by weight titanium dioxide; about 1 to about 48 percent by weight dispersant; about 5 to about 70 percent by weight ethanol; about 30 to about 75 percent by weight deionized water and less than about 1 weight percent surfactant.

13. A process for printing high resolution images on an edible substrate comprising the steps of:

- (a) providing digital image information;
- (b) processing said digital image information to prepare processed digital image information; and

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(c) printing an image from said processed digital image information on an edible substrate with an ink-jet printer using a dispersed pigment food-grade ink to obtain a printed image having resolution greater than 200 dpi even if printed using a single printhead and single pass printing.

14. A process according to claim 13, wherein said step of printing comprises printing with a drop-on-demand ink jet printer.

15. A process according to claim 14 wherein said printed image has a resolution between 300 and 1200 dpi.

16. A process according to claim 14, wherein said dispersed pigment food-grade ink comprises:

- (a) a food grade white pigment;
- (b) dispersant;
- (c) an alcohol; and
- (d) water.

17. The process according to claim 13, wherein said step of providing digital image information comprises inputting an image from a keyboard, a digital camera, a scanner, a digital video camera, or pre-recorded image format.

18. The process according to claim 14 further comprising the step of applying a coating of surfactant, glaze, binder or combinations thereof to said edible substrate prior to said step of printing,

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said coating applied in an amount effective to improve the compatibility of the substrate with the ink.

19. The process according to claim 13, wherein said step of processing said image comprises resolving the image into a series of image layers, and wherein said step of printing includes printing said image layers in multiple passes to improve the resolution of said printed image.

20. The process of claim 13, further comprising drying or fixing the image after said printing step.

21. The process of claim 13, wherein said edible is dark chocolate, milk chocolate, white chocolate, a sugar shell product, hard candy, ice cream, or pet snack.

22. A system for preparing edibles having high-resolution, consumer-selected, dispersed pigmented ink images printed thereon with an ink-jet printer, comprising:

a digital image information selection device in communication with an image processor for producing processed digital image information; and

an ink-jet printer adapted to print a high resolution image corresponding to said processed digital image information on an edible substrate.

23. The system of claim 22, wherein said ink-jet printer is a drop on demand ink-jet printer.

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24. The system of claim 23, wherein said drop-on-demand ink-jet printer comprises a reservoir adapted to contain an ink comprising food grade white pigment, dispersant, an alcohol, and water.

25. The system of claim 22, wherein said ink-jet printer, said image processor, and said digital image information selection device are interconnected by computer.

26. The system of claim 22, wherein said digital image information selection device or said image processor are available to a consumer on-line.

27. The system of claim 22, wherein said ink-jet printer, image processor and digital image information selection device are integrated into a portable apparatus.

28. A customizable process for preparing edibles having high resolution images that have been selected by a consumer ink-jet printed thereon, comprising the steps of:

selecting digital image information;

processing said digital image information to form processed digital image information;

ink-jet printing an image corresponding to said information using dispersed pigmented ink;

wherein said step of selecting digital image information is performed by an individual consumer.

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29. A customizable process for preparing edibles according to claim 28, wherein said step of selecting digital image information is performed by the individual consumer at a site, and where the step of ink-jet printing is performed at the same site.

30. A customizable process for preparing edibles according to claim 28, wherein said step of ink-jet printing is performed with a drop-on-demand ink-jet printer using a dispersed pigment food grade ink comprising: food grade white pigment, glycerine, an alcohol, and water, and not having a binder.

31. A system for enabling a user to submit an image to be printed on an edible, comprising:

a first computer adapted to receive image data from the user and communicate the image data over a network;

a second computer, adapted to communicate with the first computer, the second computer being adapted to receive the transmitted image data over the network; and

an ink-jet printer adapted to receive the image data from the second computer and print on the edible a high quality image that corresponds to the received image data.

32. A system according to Claim 31, wherein the network is the Internet and the first computer is a client computer operable to run Web browser software adapted to send and receive Hypertext Markup Language (HTML) forms over the World Wide Web.

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33. A system according to Claim 31, wherein the network is a local area network.

34. A system according to Claim 31, wherein the ink-jet printer prints on an edible substrate using a dispersed pigment food-grade ink to obtain a printed image having resolution greater than 200 dpi even if printed using a single printhead and single pass printing.

35. A system according to Claim 34, wherein the ink-jet printer is a drop-on-demand ink-jet printer.

36. A system according to Claim 34, wherein the printed image has a resolution between 300 and 1200 dpi.

37. A method for use on a system for enabling a user to submit an image to be printed on an edible, the system including a first computer, a second computer structured to communicate over a network with the first computer, and an ink-jet printer, structured to communicate with the second computer, the method comprising:

(a) the first computer receiving image data from the user and communicating the image data over a network to the second computer;

(b) the second computer receiving the communicated image data over the network from the first computer; and

(c) the ink-jet printer receiving the image data from the second computer and printing on the edible a

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high quality image that corresponds to the received image data.

38. A method according to Claim 37, wherein the network is the Internet and the first computer is a client computer, step (a) being executed by operations of Web browser software operating on the first computer and adapted to send and receive Hypertext Markup Language (HTML) forms to and from the second computer over the World Wide Web.

39. A method according to Claim 37, wherein the network is a local area network.

40. A method according to Claim 37, wherein in step (c) the ink-jet printer prints on an edible substrate using a dispersed pigment food-grade ink to obtain a printed image having resolution greater than 200 dpi even if printed using a single printhead and single pass printing.

41. A method according to Claim 40, wherein the ink-jet printer is a drop-on-demand ink-jet printer.

42. A method according to Claim 40, wherein the printed image has a resolution between 300 and 1200 dpi.

43. A system for enabling a user to submit, over the Internet, an image to be printed on an edible, comprising:

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a client computer adapted to receive image data from the user and communicate the image data over the Internet;

a server computer, adapted to communicate with the client computer, the server computer being adapted to receive the transmitted image data over the Internet; and

an ink-jet printer adapted to receive the image data from the server computer and print on the edible a high quality image that corresponds to the received image data.

44. A system according to Claim 43, wherein the client computer is operable to run Web browser software adapted to send and receive Hypertext Markup Language (HTML) forms over the World Wide Web.

45. A system according to Claim 43, wherein the ink-jet printer prints on an edible substrate using a dispersed pigment food-grade ink to obtain a printed image having resolution greater than 200 dpi even if printed using a single printhead and single pass printing.

46. A system according to Claim 45, wherein the ink-jet printer is a drop-on-demand ink-jet printer.

47. A system according to Claim 43, wherein the printed image has a resolution between 300 and 1200 dpi.

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48. A system for custom manufacturing a decorated edible item on the basis of instructions of a user, the system comprising:

a server computer adapted to:

communicate over a network with a client computer of the user,

receive over the network, from the client computer, image information submitted to the client computer by the user, and

communicate the received image information to an ink-jet printer to cause printing on the edible item of a high quality image that corresponds with the received image information.

49. A system according to Claim 48, wherein the network is the Internet and the client computer is operable to run Web browser software adapted to send and receive Hypertext Markup Language (HTML) forms over the World Wide Web.

50. A system according to Claim 48, wherein the network is a local area network.

51. A system according to Claim 48, wherein the ink-jet printer prints on an edible substrate using a dispersed pigment food-grade ink to obtain a printed image having resolution greater than 200 dpi even if printed using a single printhead and single pass printing.

52. A system according to Claim 51, wherein the ink-jet printer is a drop-on-demand ink-jet printer.

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53. A system according to Claim 51, wherein the printed image has a resolution between 300 and 1200 dpi.

54. A method on a server computer on a network for facilitating custom manufacturing of a decorated edible item on the basis of instructions of a user, the method comprising:

communicating over the network with a client computer of the user,

receiving over the network, from the client computer, image information submitted to the client computer by the user, and

communicating the received image information to an ink-jet printer to cause printing on an edible item of a high quality image that corresponds with the received image information.

55. A method according to Claim 54, wherein the network is the Internet and the client computer is operable to run Web browser software adapted to send and receive Hypertext Markup Language (HTML) forms over the World Wide Web.

56. A method according to Claim 54, wherein the network is a local area network.

57. A method according to Claim 54, wherein the ink-jet printer prints on an edible substrate using a dispersed pigment food-grade ink to obtain a printed image having resolution greater than 200 dpi even if

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printed using a single printhead and single pass printing.

58. A method according to Claim 57, wherein the ink-jet printer is a drop-on-demand ink-jet printer.

59. A method according to Claim 57, wherein the printed image has a resolution between 300 and 1200 dpi.

60. A computer-readable medium storing executable code adapted to control a server computer on a network to perform a method for facilitating custom manufacturing of a decorated edible item on the basis of instructions of a user, the method comprising:

communicating over the network with a client computer of the user,

receiving over the network, from the client computer, image information submitted to the client computer by the user, and

communicating the received image information to an ink-jet printer to cause printing on an edible item of a high quality image that corresponds with the received image information.

61. A computer-readable medium according to Claim 60, wherein the network is the Internet and the client computer is operable to run Web browser software adapted to send and receive Hypertext Markup Language (HTML) forms over the World Wide Web.

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62. A computer-readable medium according to Claim 60, wherein the network is a local area network.

63. A computer-readable medium according to Claim 60, wherein the ink-jet printer prints on an edible substrate using a dispersed pigment food-grade ink to obtain a printed image having resolution greater than 200 dpi even if printed using a single printhead and single pass printing.

64. A computer-readable medium according to Claim 63, wherein the ink-jet printer is a drop-on-demand ink-jet printer.

65. A computer-readable medium according to Claim 63, wherein the printed image has a resolution between 300 and 1200.

66. A edible product comprising a high resolution image printed on at least one surface of an edible substrate having localized three dimensional features, wherein the image is printed with drop on demand ink-jet technology.

67. The edible product of claim 66 wherein the high resolution image has a resolution greater than 200 dpi.

68. The edible product of claim 66 wherein the high resolution image has a resolution between 300 dpi and 1200 dpi.

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69. The edible product of claim 66 wherein the edible substrate is dark chocolate, milk chocolate, white chocolate, a sugar shell product, hard candy, or ice cream.

70. The edible product of claim 66 wherein the edible substrate has a coating of surfactant applied to said at least one surface and said high resolution image is printed onto said coating of surfactant.

71. The edible product of claim 66 wherein the edible substrate is substantially planar in shape.

72. The edible product of claim 66 wherein the edible substrate is substantially non-planar in shape.

73. The edible product of claim 66 wherein said high resolution image is printed onto said at least one surface and said at least one surface is non-planar.

74. An edible product produced by the method of claim 13 comprising a high resolution image printed on at least one surface of an edible substrate wherein the image is printed with drop on demand ink-jet technology.

75. The edible product of claim 74 wherein the high resolution image has a resolution greater than 200 dpi.

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76. The edible product of claim 74 wherein the high resolution image has a resolution between 300 dpi and 1200 dpi.

77. The edible product of claim 74 wherein the edible substrate is dark chocolate, milk chocolate, white chocolate, a sugar shell product, hard candy, ice cream, or pet snack.

78. The edible product of claim 74 wherein the edible substrate has a coating of surfactant, glaze, binder or combination thereof, on said at least one surface and said high resolution image is printed onto said coated surface.

79. The edible product of claim 74 wherein the edible substrate is substantially planar in shape.

80. The edible product of claim 74 wherein the edible substrate is substantially non-planar in shape.

81. The edible product of claim 74 wherein said high resolution image is printed onto said at least one surface and said at least one surface is non-planar.

82. An edible, ink-jettable ink composition comprising:

- (a) a food-grade white pigment;
- (b) a dispersant; and
- (c) an alcohol;

wherein said composition is substantially free of water.

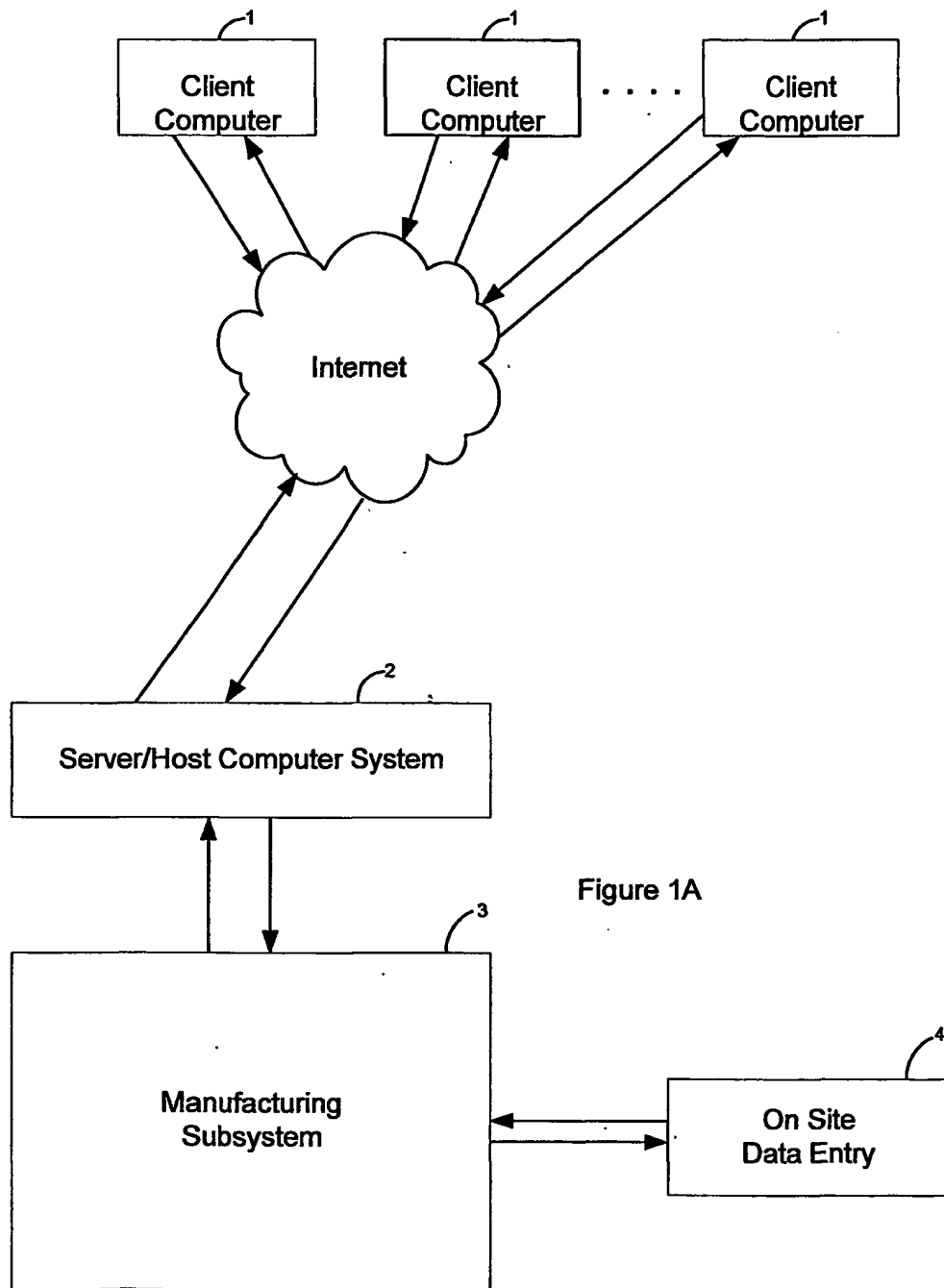


Figure 1A

FIGURE 1B

